DESIGN AND FABRICATE THE PROTOTYPE OF A MOTORIZED CUTTER FOR HARVESTING PALM FRUIT

MUHD RIZDWAN BIN MUHAMAD JAMIL

A report submitted in partial fulfillment of the requirements

of the award of the degree of

Bachelor of Mechanical Engineering

Faculty of Mechanical Engineering

UNIVERSITI MALAYSIA PAHANG

NOVEMBER 2008

SUPERVISOR'S DECLARATION

We hereby declare that we have checked this project and in our opinion this project is satisfactory in terms of scope and quality for the award of the degree of Bachelor of Mechanical Engineering.

Signature : ..……..……..

Name of Supervisor : ……

Position : ……

Date : …….

Signature : …….

Name of Panel : ……

Position : …….

Date : …….

CANDIDATE'S DECLARATION

I hereby declare that the work in this thesis/project is my own except for quotations and summaries which have been duly acknowledged. The thesis/project has not been accepted for any degree and is not concurrently submitted in candidate of any other degree.

Signature : ……

Name : MUHD RIZDWAN BIN MUHAMD JAMIL

ID Number : MA06110

Date : …….

DEDICATION

To my beloved mother and father

Muhamad Jamil Bin Afandi

Saripah Bte Ramin

To my beloved family and friends

ACKNOWLEDGEMENTS

I am grateful and would like to express my sincere gratitude to my supervisor Mr. Zamzuri Bin Hamedon for his germinal ideas, invaluable guidance and continuous encouragement. I appreciate his consistent support from the first day I applied to graduate program to these concluding moments. I am truly grateful for his progressive vision about my training in this thesis, his tolerance of my naïve mistakes, and his commitment to my future career.

My sincere thanks go to all my lab mates and members of the staff of the Mechanical Engineering Department, UMP, who helped me in many ways and made my stay at UMP pleasant and unforgettable. I am also very thankful to my entire lecturer, for their guidance and advices. Without their continued support and interest, this project report would not have been the same as presented here.

My fellow student should also be recognized for their support. My sincere appreciation also extends to all my colleagues and other who have provided assistance at various occasions. Their views and tips are useful indeed. Unfortunately, it is not possible to list of them in limited space. I am grateful to all my family members.

ABSTRACT

Nowadays, agriculture especially palm fruit have some problem such as how to increase the productivity and profit, how to reduce the cost and how to solve the problem come from foreign workers. A new motorized cutter specifically designed for palm trees was designed and developed. It comprises three criterions, easy to fabricate, low cost and light weight. By using design and fabricate the mechanical cutter, the entire problem can solved easily. There are some procedures to solve this problem such as design using several concepts, sketching and modeling the design, fabricate the prototype using suitable material and test the functioning of this machine. So the objectives are to design and fabricate the prototype of motorized cutter for a harvesting palm fruit.

ABSTRAK

Pada masa sekaranag, agrikultur terutama kelapa sawit mengalami beberapa masalah seperti bagaimana untuk meningkatkan pengeluaran dan keuntungan, bagaimana untuk mengurangkan kos dan bagaimana untuk menanggani masalah yang berpunca daripada pekerja asing. Pemotong bermotor yang baru telah direka dan dibangunkan untuk pokok kelapa sawit. Ia merangkumi tiga ciri iaitu mudah direka, kos yang murah dan beban yang ringan. Dengan merencana dan mereka pemotong bermotor, segala masalah di atas dapat diselesaikan dengan mudah. Dengan beberapa prosedur untuk menyelesaikan masalah seperti merencana menggunakan beberapa konsep, lakaran dan permodelan, mereka model menggunakan bahan yang sesuai dan menguji kelancaran mesin ini. Oleh itu, objektifnya adalah merencana dan mereka model pemotong bermotor untuk menuai buah kelapa sawit.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF SYMBOLS

%	Percent
ϕ	Diameter
°C	Degree Celsius
j_p	Total number of primary joints
j_h	Total number of higher order joints
θ	Angle
γ	Angle
Δ	Difference of range
mm	Millimeter
cm	Centimeter
kg	Kilogram
min	Minute
sec	Second
K	Kelvin

LIST OF ABBREVIATIONS

MPOB	Malaysian Palm Oil Board
RMK 9	Rancangan Malaysia Ke-9
SRC	Single Rope-and-Cutlass
DRC	Double Rope-and-Cutlass
BPK	Bamboo Pole and Knife
APK	Aluminum Pole and Knife
CAD	Computer Advance Drawing
rpm	Revolution per hour
FAMA	Federal Agriculture Marketing Authority
MARA	Majlis Amanah Rakyat
MARDI	Malaysian Agricultural Research and Development Institute
FELDA	Federal Land Development Authority
FELCRA	Federal Land Consolidation and Rehabilitation Authority

CHAPTER 1

INTRODUCTION

1.1 Background

Argriculture can define as the science, art, and business of cultivating soil, producing crops, and raising livestock or farming. Nowadays, agriculture are the new field that can give many advantages and benefits to our life especially to our economy, politics and social. There are many parts in agriculture such as coconut fruit, pineaplle, palm fruit, livestock and farming. For the new focus is on palm fruit which is Malaysia want to produce own bio-chemical that can use for fuel and any application for the consumer. Now, production in petroleum are decrease. Beside that, from BBC News on September 2008, Malaysian price for 1 litre petrol is RM 2.30 [5]. That why Malaysia focus on this palm fruit because many researchers from this country and outside believe this fruit is usefull which is can use as a fuel and can take place from petroleum.

In agriculture, there are two major input especially palm fruit which are machinery and labour (MPOB Information Series June 2007) [3]. The main objective from this input is maximizing the profit, productivity must increase and the cost must reduce. From that, the conclusion is machinery can maximizing the profit, increase productivity and reduce cost. One of the important activities in palm fruit cultivation is harvesting. Harvesting is the act of removing a crop from where it was growing and moving it to a more secure location for processing, consumption or storage. The major factor to determine the time of harvest is the maturity of the crop. The other factor is

weather, availability of harvest equipment, picker, packing and storage facilities also transport which is important consideration [7].

From MPOB Information Series June 2007, this harvesting operation requires 60% of total labour for the crop which constitutes about 50% of the total production cost [3]. It is well known that the agriculture sector in Malaysia in general and the palm fruit industry in particular depends very much on labour especially foreign labour to function in production. From this foreign labour, our country can get many problem such as social problem deu to reduction of foreign labour and much of money draining out to other country [1]. Data from the Satistics and Labour Departmentrevealed that as at June 2006, the number of foreign workers in palm fruit industry was nearly 400 000 which is about 90% of its total labour.

So the keyword to solve this problem is human or workers. Only human beings have the unique combination of eyes, brain and hands that permits the rapid identification and harvest of delicate and perishable material with minimal loss and bruising. But now is modern technology, there are many machinery that can help human to do this harvesting. Since 1982 many harvesting machines have been developed by industrial and agriculture machine manufacturer for harvesting palm fruit bunches (MPOB webpage)[10]. In developing the harvesting machine the most difficult part is to design a suitable cutter for harvesting and pruning. There are several factor were taken into consideration when developing the mechanical harvester such as ground pressure, light weight, technique to harvesting, able to both high and low harvesting, and the important ones is safety to the operator.

The main objective for this project is to design and fabricate the suitable mechanical cutter for harvesting. To achieve this objective there are several machines such as mechanical ladder, mini crawlers harvester and telescopic crane (manufacture and developed by MPOB and outside researcher)[11]. But all this machine have their own problem such as high cost and still use many workers. But there are two version machine that can use as reference to achieve the objective for this project. But this

reference machine must developed by this project to solve the problem. The problem for this reference machine is high cost which is RM5000 per unit (MPOB Information June 2007)[3] and not flexible to high and low harvesting. So the new design for this mechanical cutter must in term of low cost which is below RM1500 and flexible to high and low harvesting.

There is the two reference machine for harvesting. The first version of mechanical cutter develope by Abdul Razak Jelani et al. His mechanical cutter have been follow several criteria such as the cutter should be easy to handle and effiecient and should improve productivity. It must be able to minimize fatique to the worker during the cutting operation. The usual criteria for harvesting from palm of more than 3 meters high is attached a sickle into a pole. Many effort have been expanded in developing various type of cutting devices but the manual method still remains as the most effective way of harvesting. The sickle with its curve design could effectively get access to the fronds as well as the bunch stalks during the harvesting process. In this invention, the sickle is still used as the cutting device however the cutting operation is executed mechanically [9].

For harvesting, the vibrating action method can be adopted to this new design of mechanical cutter. Whereby the vibrating action is transferred to a vertical direction so that the cutting operation can be performed vertically. A vibrating mechanism has been selected and can vibrate at high speed in the longitudinal direction of the pole's axis. The vibration is developed by an oscillating mechanism which is a pair of bevel gears. The rotational movement from the engine is trasmitted by a cable to these bevel gears to create the rapid vibration of the sickle along the pole's axis. The speed of vibration can reach up to 3000 cycle per minutes (MPOB Information Series June 2003)[3].

A special cutter has been designed and developed to fit into the vibrating mechanism for efficient cutting. To minimize vibration transfer to the operater is at the centre of cutting at the cutter was made in line with the axis of the vibrating mechanism. This mechanical hand-held cutter consists of a special cutter, a pole and a petrol engine

of 23.6 cc which is two stroke. Its light weight of only 5.5 kg makes it easy to be carried and handled. Most of the component are mae of aluminum alloy that contributes to its lightweight [9].

The second version of the cutter also developed by the same person. This new mechanical cutter is for taller palm of 8 meter height. The machine employs similar to the first version with same cutting head and engine. A curve sickle is still used together with the specially designed vibrating mechanism for the sickle to cut. The only difference is it has a 5.60 meter composite pole which is lighter than the aluminum pole. There are two consideration in design the new cutter which is weight and stiffness. A good cutter must be light weight and have a stiff pole for easier handling and control especially when harvesting tall palms of above 6 meter. A weight of more 10 kg would be heavy and difficult to lift. Similarly with flexibility of the pole which is too flexible would make handling difficult [14].

For the new design, the chainsaw engine is use as a source for vibrating mechanism. The chainsaw engine is selected because the price for 1 unit engine is about RM800. From the source, the same concept like movement of piston and crank shaft in car engine is use to transmitted the rotational movement from the engine to the sickle. The rotational movement from the engine is trasmitted by a two cranks which connected with a small pin. These pin will connected to the lower section of shaft. The shaft can be devided into 3 parts which are lower and upper section and the transferred shaft. The lower section contains a pin connected to the crank and the set of linear bearing which allowed the movement in longitudinal direction of the pole's axis. Also for the upper section contains a set of linear bearing and the sickle connected with the screw. This linear motion make the rapid vibration of sickle along the pole's axis. From this new design, hopefully the problem such as high cost and flexible can be solve easily.

1.2 Problem Statement

In Rancangan Malaysia Ke-9 (RM9) where agriculture becomes the new focus which can give many advantages and benefits especially to our economy, politics and social. Palm fruit is one of the new targets in agriculture where still not much researchers and manufactures participate in this field. From that there are some problems arise such as how to maximizing the profit, how to increase productivity and how to reduce the cost. One of the important activities in palm fruit is harvesting. This harvesting operation requires 60% of total labor where some of the workers are foreign Labour. The problems with foreign labor are increase the social problem in our society and increase the money draining out to other country. So the ideas to reduce the dependent on workers in this harvesting, this project comes to solve all this problems where the new invention for machinery in harvesting which able to reduce the workers. By using the tools like machinery, the dependent on the foreign worker can be reduce, productivity can be increase, the cost can be reduce and the profit can be increase. From that, the main objective for this project is to design and fabricate the prototype of a motorized cutter to harvest palm fruit for commercial used can achieve.

1.3 Objectives

1.3.1 To design the prototype of the Motorized Cutter for Harvesting Palm Fruit.

1.3.2 To fabricate the prototype of the Motorized Cutter for Harvesting Palm Fruit.

1.4 Scope of Study

1.4.1 Literature study/ review

i. Make the review about other research and study relevance to the title.

1.4.2 Design

ii. Design the prototype of motorized cutter for a harvesting palm fruit using some criteria such as low cost.

1.4.3 Material Selection

iii. Select suitable material, components and parts for this new invention.

1.4.4 Fabrication

iv. Fabricate the prototype of motorized cutter for a harvesting palm fruit using suitable process and concept.

1.4.5 Documentation

v. Preparing a report for the project.

1.5 Significant of Study

This study is to design and fabricate machinery which can reduce dependent to workers especially to foreign worker which give many effect to our country such as social problem and much of money draining out to other country. To design and fabricate this machine, there are several criterion are selected such as easy to fabricate, low cost in long term, and can harvest high and low palm fruit.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Agriculture is the art and science of crop and livestock production. In its broadest sense, agriculture comprises the entire range of technologies associated with the production of useful products from plants and animals, including soil cultivation, crop and livestock management, and the activities of processing and marketing. Many different factors influence the kind of agriculture practiced in a particular area. Among these are climate, soil, and water availability, topography, nearness to markets, transportation facilities, land costs, and general economic level. The primary agricultural products consist of crop plants for human food and animal feed and livestock products. Nowadays, palm fruit is part of the famous agriculture which can product a lot of product from it. For example like oil, soap, butter, cream and cheese.

2.2 Palm Fruit

The palm fruit is a tree without branches but with many wide leaves at its top. It has become the world's number one fruit crop because of its unparalleled productivity. Generally, for fruit crops, the majority of the mechanical harvesting systems utilized today are shake-catch systems. Each tree is visited for harvesting every 10 – 15 days as fruit bunches ripen throughout the whole year. The stalks of the palm fronds underlying a bunch are first cut, after that the stalk of the bunch is cut and it is allowed to fall freely onto the ground. Harvesting schedule will depend on the ripening of fruits as observed

on plantations. When a fruit is fully ripe, it loosens itself from the bunch and drops on the ground or it becomes easily detachable (C. Nwajiuba et al) [6].

Figure 2.1 Palm Fruit Tree and the Parts of Palm Fruit

Source: http://www.answers.com/topic/oil-palm

2.3 Harvesting

In agriculture, harvesting is the process of gathering mature crops from the fields. Reaping is the harvesting of grain crops. The harvest marks the end of the growing season, or the growing cycle for a particular crop. Harvesting in general usage includes an immediate post-harvest handling, all of the actions taken immediately after removing the crop—cooling, sorting, cleaning, packing—up to the point of further on-farm processing, or shipping to the wholesale or consumer market.

2.4 Previous Method of Harvesting

The previous method to harvesting, the criteria of design and the recommended design are the issues frequently mentioned in the literature (D.A. Adetan, L.O. Adekoya and K. A. Oladejo Department of Mechanical Engineering) [7].

Locally, short trees within arm-reach are harvested using either the cutlass or the chisel to cut the bunches and fronds. On the other hand, very tall trees above 9 m in height are harvested using high technology machinery. There are two methods in harvesting which is the single rope-and-cutlass (SRC) or the double rope-and-cutlass (DRC) method. The SRC method is more common because it is relatively much faster though less safe. In this method, the harvester manually climbs the tree by the use of a rope tied around the tree and his torso. When arm-reach of the crown, the harvester uses a cutlass to cut the fronds and bunches. Medium-height trees beyond arm-reach up to a height of about 9 m are harvested using the bamboo pole and knife (BPK) method [12]. In this method, a Malaysian knife, which is a curved knife with the sharp edge along its convex side, is attached to the end of a bamboo pole. The length of the pole depends on the average height of the trees on the plantation plot to be harvested. The harvester stands on the ground while the pole and knife are raised to the tree crown in order to harvest the bunches.

Yet another method is the Aluminum pole and knife (APK) method. In this method, a 40 mm diameter aluminum tube replaces the bamboo pole of the BPK method. It works very well and even faster than the BPK method for trees of height below 5.5 meter. Above this height, bending of long harvesting poles that carry relatively heavier cutting knives on top constitutes a very serious problem as it becomes very difficult to engage the stalks of palm fronds and bunches. Indeed, a lot of time and energy (and therefore production cost) goes into oil palm harvesting. Such an enormous amount of energy is required for harvesting oil palm that even cutting a single frond alone, using the sickle cutter (the Malaysian knife), could require the exertion of a force as much as 18,048 N for the most matured frond (Jelani et al., 1999) [2].

Harvesting from the older trees took more man-days. The situation, most likely, has not changed today because harvesting is still being done manually. Many attempts have been made to reduce the drudgery of the harvesting of oil palms. Webb (1976) worked on an oil palm tree climbing cycle. Test results showed that the cycle was not efficient for palm trees and it was not comfortable for the harvester to use. A lot of